Protocol for Compliance Testing of Nonwood Baseball Bats for Use in Short-Season Minor League Baseball

25-January-2007

Major League Baseball only allows the use of bats made from a single piece of solid wood in its games. One exception to this rule is Minor League short-season, where players are allowed to use composite bats that have been evaluated and approved by Major League Baseball to be comparable to one-piece solid northern white ash bats. This protocol identifies the evaluation process used. This scientific evaluation is performed by the University of Massachusetts Lowell Baseball Research Center. If the results are satisfactory to the Office of the Commissioner of Major League Baseball, then players may use the bats made of the evaluated design in the allowed leagues.

Introduction

A series of laboratory tests were developed over several years to determine the physical properties, batted-ball speeds and durability of nonwood (where nonwood is used to denote any bat that is not made from one solid piece of wood) baseball bats. The values of each property are compared to that of traditional solid northern white ash wood bats.

All testing, comparing solid-wood bats and nonwood bats, is conducted in the laboratory. Batted-ball performance comparisons are made using the procedures developed for certifying nonwood bats for use in college and high school baseball. Durability comparisons are made using several different impact sequences in a durability testing system. Bat ultimate strengths and flexural stiffnesses are measured by static loading tests.

Major League Baseball will consider composite bats for approval when they are similar to solid-wood bats. The composite bats must have a performance very similar to wood. The composite bats must look like a wood bat. Composite bats are often desirable because they can be more durable than solid-wood bats, but an evaluated bat must not be too durable (i.e., the bat should be able to break when jammed on an inside pitch). Other physical properties (i.e., weight, barrel diameter, length, moment of inertia, modal properties, strength and stiffness) should also be similar to bats made from a single piece of solid wood. Some evaluated bats have included bats made from laminated pieces of wood and others have had sections made from fiber-reinforced composites.

Inertial and Physical Characteristics

The length, weight, barrel diameter, center of gravity (CG) and mass moment of inertia (MOI) are measured for a minimum of two samples of compliance bats and two similar-length solid-wood ash baseball bats. The MOI is effectively the measurement of the "swing weight" of the bat. If a composite bat were to have a lower MOI than the solid-wood bat, the composite bat would be easier to swing. A single compliance bat will also be cut from end to end to determine the internal structure of the bat.

Modal (Vibration) Testing

Modal testing is performed on a minimum of one nonwood bat and one solid-wood bat of similar length. The natural frequencies of the first and second bending modes are measured along with the locations of the nodes of the primary (first) mode of vibration. The natural frequencies are a measure of the bat's flexural stiffness with lower natural frequencies representing a more flexible bat.

Batted-Ball Performance Testing

Batted-ball performance testing is used to evaluate if the nonwood bat has any performance difference from that of solid-wood bats. A minimum of one nonwood bat and one solid-wood bat must be compared using either Method A or B.

Method A:

Batted-ball performance testing is conducted using a machine with two separate motors, one motor swinging the bat at a speed of 66±1 mph at the 6-in location and the other motor swinging an arm holding a major league baseball, where the baseball speed is 70±2 mph. The batted-ball speed is measured immediately after impact. Both the nonwood bat and solid-wood bat are impacted in accordance with the NCAA Baseball Bat Certification Protocol (September 1999) and the results are compared.

Method B:

Batted-ball performance testing is conducted using an air cannon test system that fires a major league baseball at 136±2 mph into the baseball bat that is at rest and mounted on a pivot allowing it to freely rotate after impact. These tests are performed in accordance with the ASTM Standard F2219-05 and the NCAA Baseball Bat Certification Protocol (November 2005). The calculation of the Ball Exit Speed Ratio (BESR) is then used to determine the batted-ball performance of both the composite bat and solid-wood bats. The performances of both bats are compared to determine if there is a performance advantage of swinging either bat.

Static-Strength and Flexural Stiffness Testing

Static-strength tests are performed on a minimum of three nonwood bats and three solid-wood bats using a three-point bending setup. The lower supports are located near the node locations of the primary bending mode. The load is applied through a 3-in. diameter loading block made of ash and located at the midpoint between the supports. The loads are measured and applied using an Instron, which is a universal testing machine. The loading condition is representative of a failure mode that could cause handle fracture during field play.

High-Speed Durability Testing

High-speed durability tests are performed on a minimum of five nonwood bats and five solid-wood bats using the durability test system. A minimum of three of the following five different impact sequences must be used to compare pairs of nonwood and solid-wood bats with matching lengths and weights. During each sequence, high-speed video is saved to allow for slow-motion analysis of each break. Each separate comparison will be used to understand the durability of the nonwood bats and to determine if the nonwood is appropriate for use in short-season leagues.

1. One single impact at the 19-in. location (measured from the barrel end) at an impact velocity of about 135 mph
2. Repeated impacts at the 11-in. (inside hit) location starting at an impact velocity of 105 mph and increasing by 5 mph with each subsequent impact
3. Repeated impacts at the 2-in. (outside hit) location starting at an impact velocity of 130 mph and increasing by 5 mph with each subsequent impact
4. Multiple impacts starting at the 6-in. (typical sweet spot) location with an impact velocity of 160 mph and stepping in towards the handle by 1-in. increments with each subsequent impact. The velocity is adjusted according to impact location, keeping the 6-in. combined pitch/swing velocity constant at 160 mph.
5. Multiple impacts starting at the 6-in. (typical sweet spot) location with an impact velocity of 160 mph and stepping out towards the barrel end by 0.5-in. increments with each subsequent impact. The velocity is adjusted according to impact location, keeping the 6-in. velocity constant at 160 mph.